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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** X-ray diffraction on small ensembles and on single Ge is-lands	**Experiment number**: SI-1395
Beamline: ID10B	**Date of experiment**: from: 06.12.2006 to: 12.12.2006	**Date of report**: 28.02.2007
Shifts: 18	**Local contact(s)**: Dr. Alexej Vorobiev	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

We have measured a series of InAs/InAsP core-shell wire structures grown on Si(111) substrates using a new Au-free chemical vapr deposition method developed at the University of Lund, Sweden [1,2]. First, wires of (nominally) pure InAs are deposited, which measure about 100 nm in diameter and are several nm long. Already from SEM a good orientation of the wires along the [111] direction is observed, as well as a hexagonal cross-section. X-ray diffraction (XRD) experiemnts in coplanar diffraction geometry and grazing incidence diffraction (GID) confirm a good epitaxial relationship between wires and substrate. The wires studied during this beamtime are covered by a shell of an InAsP alloy with different InP concentrations and different shell thicknesses in the range of 5 to 20 nm (all nominal parameters). The main question addressed here is the strain state of wire and shell material, since this determines the optoelectronic properties of the wires. More practical, the question is up to which mismatch/thickness values the shell can be grown pseudomorphically, without the intriduction of dislocations or other defects. The XRD experiment are complemented by photoluminescence investigations performed at the University of Linz, which are still in progress.

In order to reduce background scattering from the substrate and receive a “clean” signal from the wires, we measured first in GID geometry. However, this is true only with respect to the substrate; with respect to the wires, which stand perpendicular to the substrate, the scattering takes place at lattice planes parallel to the wire axis, and represents a “steep incidence, steep exit” geometry. Considering this and the small diameter and statistical arrangement of the

wires, the scattering experiments can be well described by kinematical scattering theory. As found in previous experiments (SI-1245, see also Ref. [1]), it is possible to perform measurements at reflections forbidden for the cubic substrate: due to stacking faults of the (111) planes in the wires, they contain hexagonal segments. Choosing reflections allowed for these hexagonal segments but forbidden in cubic material, the substrate scattering can be completely eliminated. Figure 1 shows measured reciprocal space maps (RSMs) around the (10-1.0) reflections (corresponding to the cubic 1/3(22-4) reflection; gray scale intensities) of two wires with 5 nm and 20 nm shell thickness and a nominal shell composition of x_{InP}=0.15. It can be seen that the InAs core and InAsP shell give rise to two separate reflections, more pronounced for the thicker shell. The latter gives rise to a peak with a larger separation from the InAs peak, indicating a larger degree of elastic relaxation. The black contours in Fig. 1 showsthe maps compared with simulations calculated using FEM and kinematical scattering theory. We found that the InP content of the shell is about 4 times larger than the nominal values. This indicates that the growth conditions for the deposition of a shell around an existing wire are significantly different from the case when a pure wire of the composite material is grown. Further studies with sample series where the growth parameters asre varied over a larger range are required to verify these results and establish the proper growth conditions for predictable production of core-shell wire structures.

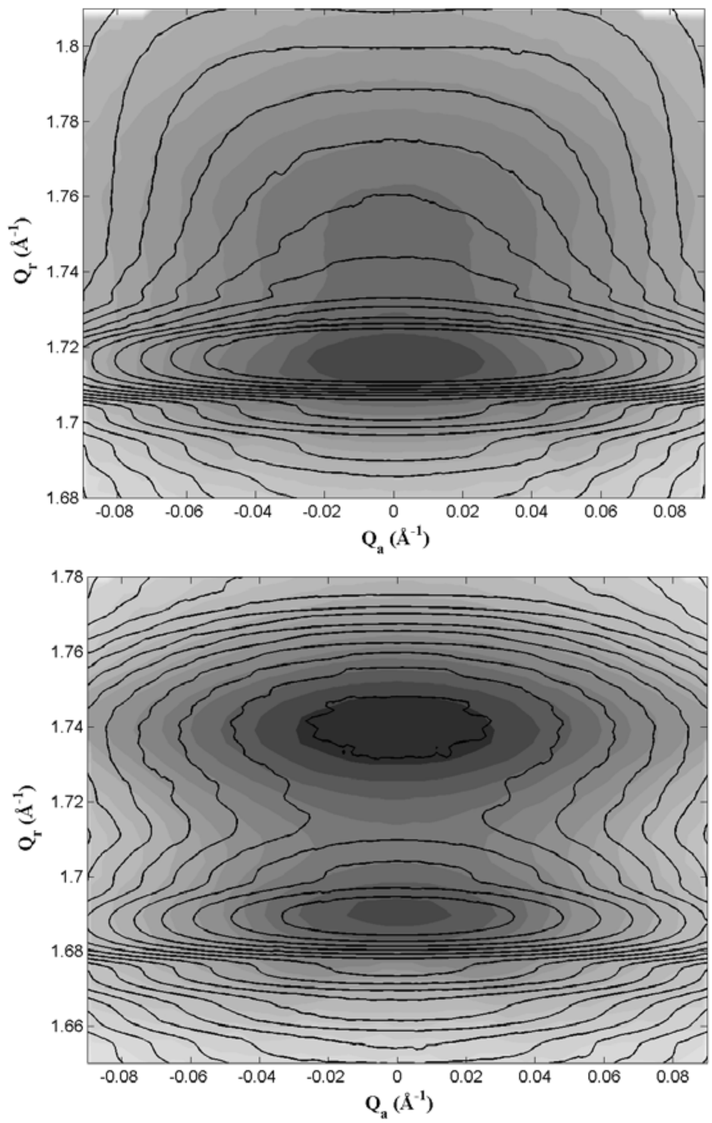

Fig. 1: Reciprocal space maps of two core-shell wire structures with 5 nm (upper panel) and 20 nm (lower panel) shell thickness.

References

[1] B. Mandl, J. Stangl, T. Mårtensson, G. Bauer, L. Samuelson, W. Seifert, Nano Letters 6, 1817 (2006).

[2] Th. Mårtensson, J.B. Wagner, E. Hilner, A. Mikkelsen, C. Thelander, J. Stangl, B.J. Ohlsson, A. Gustafsson, E. Lundgren, L. Samuelson, W. Seifert, submitted